DEFENCE
CAPABILITY

THE UNIVERSITY OF
NEWCASTLE
AUSTRALIA

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INTRODUCTION

The University of Newcastle is uniquely placed to collaborate with the defence industry, driving breakthroughs that will make positive contributions to both global security and modern life. Not only do we have a breadth of research and teaching expertise, but our location is ideal for pursuing close collaborations with the Hunter region's thriving and diverse Defence sector.

By forging these partnerships, our combined expertise and resources will enable us to develop technologies that not only support Defence related industries and personnel, but also have widespread applications to improve many aspects of daily life. These include innovations in health, agriculture, transportation, manufacturing, cyber security, advanced automation and much more.

We also leverage our expertise and networks to train the next generation of scientists, engineers, innovators and leaders. By offering sector-leading degree programs in areas such as aerospace systems engineering, cyber security and renewable energy, we are preparing our graduates with the advanced skills they need to excel in priority industries driven or influenced by Defence.

By collaborating with defence industry partners, we aim to develop and champion innovations that make a positive difference in our world.

RESEARCH

The significance of our research is reflected in the Australian Government's Excellence in Research Australia (ERA) assessment, which awarded the University of Newcastle the highest possible '5' rating across 30 research fields, placing us in the top seven Australian universities for research quality 'well above world standard.' The University is top nine in Australia for research income*. We are proud that our researchers are among the world's best.

Through our world-class research and strong national and international partnerships, we are driving innovation that challenges conventional thinking, breaks new ground and changes lives. The University has a strong focus on collaboration in research and education across our Science, Technology, Engineering, Mathematics, and Medicine (STEMM) disciplines. Our researchers work across disciplines to drive innovation, business development, commercialisation and impact.

EDUCATION

Our degrees are shaped around global perspectives, work placements and entrepreneurial approaches to study, to develop the problem-solvers and innovators of the future. For more than 50 years, we have made it our mission to deliver superior education to motivated and talented students from all walks of life. The University's academic strengths extend to chemistry, engineering, mathematics, life sciences, environmental sciences, architecture, sociology, history, literature and many more, each contributing to the rich and diverse academic culture that is valued by our students, colleagues and community. Our graduates are career-ready, globally competitive and prepared to meet the needs of the future Defence and related industry workforce.

PARTNERSHIPS

We have established strong partnerships with government and industry to drive innovation across areas of national and global significance. Our flagship research institutes, the Newcastle Institute for Energy and Resources (NIER) and the Hunter Medical Research Institute (HMRI) are among the most significant in their fields in Australia and deliver cross-disciplinary research and advancements.

Our institutes not only support cross-disciplinary research – they also help ensure our discoveries are translated to create real-world impact.

- **HMRI** is a multidisciplinary partnership between the University of Newcastle, Hunter New England Local Health District and the community. It provides a unique environment for researchers and clinicians to work together to develop innovative solutions to community health needs. From neuroscience and mental health, through to cancer, reproductive health, respiratory disease and more, the research carried out at HMRI leads to better clinical care, more competitive commercial products and improved healthcare guidelines.
- **NIER** leads the way in research that improves energy production, storage and distribution. The $30 million research facility is on a scale unmatched by any other university in Australia and brings together over 300 university researchers to work with community and industry partners in the areas of sustainable energy production and use.
- With the support of the NSW Government's Boosting Business Innovation program, we have established the **Integrated Innovation Network (I2N)** across the Hunter region, which includes the I2N Hub Williamtown, located in the Aerospace precinct at Williamtown, NSW.

INFRASTRUCTURE

We are continually investing in cutting-edge infrastructure and new technologies to support our world-class education and research. Over the next decade, technology and innovation will continue to disrupt the global economy, and the impact of seismic geopolitical events will be felt worldwide. Against this backdrop, we are committed to delivering education and conducting research that will make our nation and our world more prosperous, resilient and equitable.

STRONG PARTNERSHIPS

The University is committed to growing the regional economy of Newcastle, the Hunter and the Central Coast. Increased collaboration with local, national and international industry on identified areas of growth and national priority is a key focus of our overall strategy. As such, the University is working to further strengthen its connections and is engaging with stakeholders to develop new strategies to boost participation with business, government and industry. Key defence initiatives include:

NSW DEFENCE INNOVATION NETWORK (DIN)

The University of Newcastle is a partner in the NSW Defence Innovation Network, which is forging new partnerships with NSW defence businesses, NSW universities, NSW government and the Defence Science and Technology Group (DST), with the primary aim of making NSW businesses more competitive and innovative, and able to better respond to the national Defence Research and Development objectives as outlined in the Australian Department of Defence 2016 Defence Industry Policy Statement. Our research groups focus multi-disciplinary skills on problems aligned with Defence priorities to improve the Australian Defence Force's warfighting capability and grow Australia's global defence export industry.

I2N HUB WILLIAMTOWN

Located at the Williamtown Aerospace Centre, the I2N Hub Williamtown is a purpose-designed facility which offers a co-location working space for researchers, postgraduate students and industry to work collaboratively on projects of mutual benefit for the defence, security and aerospace sectors.

Collaboration between government, industry and academia is essential, and the Hub's collaborative program focuses on strengthening relationships and leveraging capability to drive regional development through defence jobs, fostering innovation, commercialisation and partnerships.

I2N Hub Williamtown is one of three innovation hubs in the Hunter Region which together comprise the I2N. The I2N is a University initiative established in 2016 with the support of the NSW Government. Its programs are designed to support and develop innovation and entrepreneurship across the region and link startups and small to medium sized enterprises to research organisations. These partnerships build strong local business communities and stimulate economic growth in NSW.

UNIVERSITY OF NEWCASTLE DEFENCE INNOVATION ADVISORY GROUP (DIAG)

We have established the University of Newcastle DIAG which connects representatives from Defence and defence industry, business and government – providing a collaborative forum to:
- Establish a joint strategic focus encompassing cooperative relationships and integrated planning with industry, business and government
- Enhance understanding of Defence and defence industry needs and goals
- Initiate the research and development discussion with regional and national Defence and defence industry
- Increase collaboration with Defence and defence industry organisations.

ALTITUDE ACCORD

Altitude Accord is a strategic partnership between Lockheed Martin Australia (LMA), the University of Newcastle and Regional Development Australia (RDA) Hunter. The partnership is a commitment to creating genuine opportunities for Australians in regional centres and growing economic prosperity in regional Australia. The 'Altitude Accord' supports the development of tailored and targeted initiatives to develop the future high-value skills of a new generation workforce. LMA has funded RDA Hunter to facilitate the 'Altitude Accord' with the University of Newcastle, which will see an investment of more than $40,000 over two years.

Specifically, the accord will enable:
- Scholarships for first year University of Newcastle Aerospace Systems Engineering students. The scholarship will facilitate an education and research program tour with the LMA STELaRLAB in Melbourne and the Endeavour Centre in Canberra.
- LMA's engagement with the University of Newcastle on the curriculum design of the undergraduate aerospace degree.
- Facilitation of closer working connections between the University of Newcastle and the STELaRLab based at Melbourne University.
- Upcoming opportunities for a University lecture series featuring Lockeed Martin's Australian and international industry experts.

RESEARCH CAPABILITY

The University has established a number of research institutes and centres in partnership with government and industry. These support researchers to deliver a broad range of expertise relevant to Defence, Security and Aerospace that aligns with key areas of national priority, including:

BIOMETRIC TRAINING ENHANCEMENTS

Specialising in collection, analysis and interpretation of biometric data, with the objective of delivering improved training outcomes across health, defence, and agricultural settings. Focused on improving outcomes in high intensity 'first responder' training programs and providing expertise in utilising biometric data to reduce stress, improve resilience and deliver better performance under pressure.

COGNITIVE MODELLING

Developing quantitative models of human decision-making to assess the impacts of cognitive load and data presentation. A University research team working in the field of psychology have developed broadly-adopted models and statistical analysis techniques to map decision making and currently work with Defence and industry to optimise human-to-human and human-machine interfaces.

SYSTEM EVALUATION AND DESIGN

Evaluating the performance of human-machine interfaces and including work with interactive technology platforms such as virtual and augmented reality in a range of industries. Research from the I3 Lab spans areas from cognitive load in simulation training to physiological responses and other objective measures of interface performance and can be applied in areas from defence and aerospace industries, to mining and public transport.

CYBER SECURITY

Cyber security is an integral part of Defence's strategy to maintain confidentiality, integrity and availability of its systems and data in a constantly changing, interconnected environment. Current research includes:
• cloud security
• secure virtualisation
• internet of things security
• big data security
• trusted computing
• software defined networks security
• malware and security attacks
• data analytics for malware analysis
• secure software design
• secure distributed applications
• security in networked control systems
• applied cryptography.

SECURITY AND TRUST IN AUTONOMOUS SYSTEMS

This area is an important part of the University's Cyber Security Research Strategy. Distributed and networked autonomous systems will necessarily have elements deployed in untrusted environments, and will require protection as they will be targets of attacks. Research capabilities include security attack detection models, secure virtualised system architectures, trust-enhanced secure decision making, cloud data security, authorisation in autonomous systems and software-defined networks-based security.

MACHINE VISION

Advanced pattern recognition and efficient processing of image data is a significant part of the University's robotics research capability, as is the development of machine vision technologies used to identify targets on complex backgrounds in dynamic environments on small, mobile units with limited processing capacity.

DEEP LEARNING

Researchers are understanding the inner workings of convolutional neural networks (CNNs) by visualising and mathematically analysing how they represent data in their hidden layers. This helps to build confidence in a CNN's output decisions in data analytics. They are also developing completely new CNNs that dramatically accelerate object detection to the point of real-time tracking with high frame rates. Methods for accelerated CNN training include synthetic image generation techniques from computer graphics.

ADVANCED SENSORS

Expertise in advanced sensor platforms (airborne and satellite-borne) incorporating a combination of inputs such as global positioning system, inertial navigation system, gravity, magnetic, radar/lidar and hyperspectral imaging are being engineered by researchers to generate and process data which can be used for environmental and climate monitoring and threat detection. The research group's expertise on satellite remote sensing has been competitively selected to join a group of science team members working on NASA's satellite missions for the Earth and the Moon.

ACTUATION

The Precision Mechatronics Lab work in a number of defence-related fields. The primary areas of focus include mechatronic and robotic technologies for fabrication, healthcare, imaging and Defence.

DEPLOYABLE POWER STORAGE AND GENERATION

Energy and resources is a primary focus of the University of Newcastle and is an area of alignment between existing research capability and Defence priorities. NIER is a world-class scientific research and testing facility with extensive laboratory space and large-scale pilot plant facilities, which has the ability to take technology from the laboratory scale up to pilot phase testing. Key areas of NIER's resident research groups include energy generation and storage.

ADVANCED ENERGY STORAGE

The Priority Research Centre (PRC) for Frontier Energy Technologies and Utilisation has expertise spanning baseline power generation to portable generation and energy storage. Energy generation and storage is a priority area for Defence. Deployable solutions for energy generation and storage must be robust and any increases in efficiency for existing technology are of particular importance given the cost and risk of delivering fuel to a remote or hostile environment. Key capabilities include all forms of electrochemical energy conversion and storage i.e. batteries, capacitors and fuel cells, chemical looping and oxygen generation systems.

ORGANIC ELECTRONICS

The PRC for Organic Electronics has developed methods for painting and printing photovoltaic materials onto a variety of surfaces to produce solar power easily in remote environments. The technology can be produced quickly and is very low weight and transportable, therefore allowing rapid deployment with minimal transport and logistics costs to remote or otherwise difficult areas.

NERVE AGENT DETOXIFICATION AND NEUTRALISATION

Researchers at the University of Newcastle's Global Centre for Environmental Remediation (GCER) have developed methods of quickly neutralising common nerve agents. The enzymatic compounds developed for this purpose can be delivered in a number of different ways, and this approach to neutralising chemical threats represents a diverse and adaptable research capability.

CONTAMINATED LAND AND WATER REMEDIATION

With support from the Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE), GCER researchers have developed a variety of approaches to remediate persistent organic contaminants. Using novel filtration methods or such processes as thermal decomposition and phytoremediation, potentially hazardous compounds including dioxins, hexachlorobenzene and per- and poly-fluoroalkyl substances can be removed from soil or water.

FUNCTIONAL ADVANCED NANOSTRUCTURED MATERIALS FOR ENERGY AND ENVIRONMENT

The team of material scientists and engineers at the Global Innovative Centre for Advanced Nanomaterials (GICAN) have developed a complete gamut of advanced functional nanomaterials for applications in energy storage, energy generation and conversion, adsorption and degradation of toxic compounds including trichlrobenzene, carcinogens, poly-fluorinated alkyl substances, and toxic metals, and further provide solutions for the selective capture of CO_2 in a closed submarine environment. The Centre also has a significant expertise on the design and development of multifunctional hybrid nanostructured materials for clean fuel generation through photocatalytic pathway and fire resistant cloths.

NEW COURSES IN 2019

BACHELOR OF
AEROSPACE SYSTEMS ENGINEERING (HONOURS)

Aerospace Systems Engineering involves a systems approach to the design, efficient operation and modification of high-tech devices for the aeronautical and defence industries.

A key challenge for the development of aerospace systems is the need to be as lightweight as possible, yet highly reliable. Aerospace Systems Engineering is about understanding and controlling the response of aerospace structures to complex interactions using a broad range of technologies. Students can focus on aircraft structural design and high-performance materials or concentrate on the control of complex interacting aerospace systems.

Students will build critical technical engineering skills across their degree and culminating in a final year research project, specialising in:
· aircraft operations and performance
· principles in flight and avionics
· aerospace design and materials
· embedded systems engineering

GRADUATE CERTIFICATE IN
CYBER SECURITY

There is a significant shortage of cyber security skill and expertise throughout the world. The Graduate Certificate in Cyber Security is designed to provide a working knowledge of important security standards, techniques to exploit the current systems and networks, and technical depth of expertise in the design of secure systems and their application to real-world problems in different industry sectors.

The program provides a thorough understanding of cyber security threats and attacks to identify, analyse and apply security techniques and mechanisms to develop secure protocols. Students will learn privacy concepts and techniques for privacy enhanced technologies, as well as best practices for cyber security and secure knowledge in:
· data security
· system and network security
· systems and network administration
· security attacks: analysis and mitigation strategies

MASTER OF
CYBER SECURITY

Cyberspace has profoundly transformed the way we live and do business. We are increasingly reliant upon networked applications for assessing information and making critical business decisions, so it is essential for individuals, enterprises and governments to be able to secure cyberspace from attacks.

The Master of Cyber Security has been designed to provide quality training in the areas of cyber systems and infrastructures, and their applications, thereby helping to address severe global skill shortages in these areas. This professional qualification will allow individuals to harness expertise to safeguard cyber security across a variety of industry sectors and secure knowledge in:
· data security
· system and network security
· security attacks: analysis and mitigation strategies
· security standards and practices in industry
· engineering complexity

GRADUATE CERTIFICATE IN
INNOVATION MANAGEMENT AND ENTREPRENEURSHIP

The Graduate Certificate in Innovation Management and Entrepreneurship will help strengthen students' capacities as an organisational leaders or entrepreneurs, developing creativity and adaptability to take business or ideas into the future. These skills are relevant to a number of sectors, including Defence.

This program helps students develop their abilities to showcase their unique values in the new age of business processes and turn ideas into reality. Students will study topics including:
· Entrepreneurship and Innovation
· Enterprise Development and Growth
· Creativity and Design Thinking

MASTER IN
INNOVATION MANAGEMENT AND ENTREPRENEURSHIP

The Master of Innovation Management and Entrepreneurship will increase student's value in any organisation driven to stand at the forefront of ever-changing technologies and the business-solutions landscape. As the workforce moves towards a more innovation-focused future, the ability to innovate enables individuals and organisations to gain an important advantage over competitors.

This program is designed for leaders, managers and entrepreneurs striving to succeed in today's world, where it is increasingly recognised that entrepreneurship and innovation are central to sustained competitive advantage in a constantly-changing business landscape. These skills are relevant to a number of sectors, including Defence.

Students will study topics including:
· global innovation management
· entrepreneurship for start-ups
· creativity and design thinking
· marketing management and planning

BACHELOR OF
RENEWABLE ENERGY ENGINEERING (HONOURS)

One of the biggest challenges humankind faces is the transition to a renewable energy economy. The success of this evolution depends on the creative solutions of a new generation of renewable energy engineers with specialised skills. Spanning the disciplines of chemical, electrical and mechanical engineering, the Bachelor of Renewable Energy Engineering (Honours) will equip students to work across the whole spectrum of technologies for renewable energy capture, conversion, storage, delivery and management.

Students will build critical technical engineering skills in:
· solar and wind
· geothermal, hydro, ocean and hybrid systems
· carbon accounting and energy auditing
· power electronics and renewable energy systems
· bioenergy
· energy storage systems

The demand for professionals with the capacity to create and implement new ideas to deliver value for their organisations is ever-increasing. The appetite for pioneering ventures has never been stronger and the capacity to provide creative, innovative opportunities for business is of growing value, especially in the Defence sector.

These programs in Innovation Management and Entrepreneurship are innovative in themselves. They promote a balanced approach to theoretical knowledge, models, and concepts, and encourages students to hone their skills and know-how to apply ideas to real-world scenarios.

CONTACTS

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